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(57) Abstract

A fabric is impregnated with a dilute solution of polyethylene glycol, dried and the polyethylene glycol is cured onto the fabric to give a final pick-up of 0.5 to 8 % polyethylene glycol. Fabric treated with this low pick-up of polyethylene glycol permanently bonded onto the fabric can be cotton and can have cooling properties and non-iron properties.

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Fibrous Products and their Production

This invention relates to fabrics, and yarn from which they may be formed, on to which material has been reacted so as to give permanently improved performance properties to the fabrics. The invention is of particular applicability to the production of fabric for clothing which will give a cooling effect to the wearer when exposed to warm or hot ambient conditions. The invention can also be applied to improvement in soil release and crease resistance and abrasion properties of fabric.

Numerous methods are known for reacting various chemicals on to fibres either as yarn or as preformed fabric so as to modify the properties of the fabric. For instance it is conventional to impart easy-care properties to various fabrics by reacting on to the fabrics (or yarn from which they are formed) materials such as dimethylol dihydroxy ethylene or methylene urea in the presence of an acid catalyst. Some such processes are described in GB 877,582, GB 1,034,453 and WO82/00164.

It is generally accepted that fabrics made from linen can have particularly desirable performance properties under humid conditions, including very rapid pick up of moisture, but that they can suffer from some other disadvantages, including cost. Fabrics made from viscose are relatively cheap but have rather poor properties, for instance when exposed to humidity. It is described in WO82/00164 how to modify viscose fibres chemically so as to improve their properties when exposed to humidity. Such materials are available under the trade name Molinease.

It is well accepted that linen, and fabrics which have properties approaching those of linen, are beneficial when used in hot or humid weather because of the cooling effect that they can impart to the wearer. The present invention is primarily aimed at providing clothing which gives an improved cooling effect, wherein the fabric can be based on linen or can be based on other fibres so that the cooling

effect of the fabric may approach or be equivalent to that of linen.

Bruno and Vigo describe in Textile Chemist and Colourist March 1988, volume 20, number 3, pages 17 to 20 fabrics having improved thermal storage and other properties. The thermal data in the article by Bruno and Vigo all emphasises the improved thermal storage properties of the fabrics and thus indicates that they would promote a feeling of warmth. The Bruno and Vigo article also mentions other properties including moisture regain and water of imbibition, but these are not normally associated with the thermal properties of the fabric.

The fabrics described by Bruno and Vigo are the exact opposite of those desired in the invention, in that Bruno and Vigo fabrics increase retention of heat rather than improve the cooling effect.

The Bruno and Vigo fabrics are based on cotton and cotton polyester blends and in the examples are made by impregnating with a bath of 50% (500g/l) polyethylene glycol 1000, 11% dimethylol dihydroxy ethylene urea, 3.3% magnesium chloride, and 1% citric acid to a wet pickup of about 100% followed by drying at 70°C and then curing for two minutes, followed by washing. The data demonstrates dry add-on values generally ranging from 21.6 to 52.8%. These high add-ons will, in addition to giving heat retention, also tend to affect significantly the handle of the fabrics.

In one example, however, the dry add-on is said to be 10.6%. This process is conducted with curing at 100°C. We show below that curing for 2 minutes at 100°C does not cause significant bonding onto the fabric. It is therefore clear that this 10.6% is merely the amount which was not washed off by the first wash and that it is not permanently bonded to the fabric and most or all of it will be washed off by subsequent washes. Accordingly it is irrelevant to the production of commercially useful fabrics since these must have permanent properties. It is essential with such

fabrics that substantially all the add-on on the fabric when received by the customer should remain permanently bonded despite repeated washings.

One object of the invention is to provide a fabric having permanent properties such that the fabric, when worn in warm or hot weather, will give the wearer a cooling sensation. Another object is to modify permanently the properties of cotton and other non-linen fibres so that they approach or exceed the desirable properties (especially as regards the cooling effect and rate of water absorption) of linen. Another object is to provide a fabric which can react strongly with isocyanate-based adhesives so as to form a polyurethane adhesive layer firmly secured to the fabric. Another object is to provide a cotton or other fabric which has improved non-iron and comfort properties. Another object is to provide a fabric having permanently improved soil release and/or crease resistance and/or abrasion resistance. Other objects are to provide yarns which can be woven or knitted to form such fabrics.

In one broad aspect of the invention, we provide a fibrous product which is selected from fabrics and yarns and which comprise fibres of cellulose, wool or polyamide and which includes polyethylene glycol substantially uniformly distributed through the product and in which the polyethylene glycol is present in an amount of 0.5 to 8% (based on the dry weight of cellulose, wool and polyamide fibres and preferably based on the total product) and substantially all the polyethylene glycol is substantially permanently bonded to the fibres of the product.

The product usually contains textile cross linking agent as well as the PEG, and the total add-on of these two materials is usually in the range 1 to 15%, preferably 1 to 12%, by weight. Generally the total add-on onto the fabric is within this range.

The low add-on of polyethylene glycol (and usually crosslinking agent) which is required in the invention is

best achieved by applying to the yarn or fabric a dilute aqueous composition of the polyethylene glycol and crosslinking agent and optionally washing the yarn or fabric. By applying this dilute solution and curing it, the desired low add-on values are achieved. The process can be conducted on yarn, but preferably the process is conducted on fabric.

In particular, a process of the invention comprises impregnating the fabric, or the yarn from which it is formed, with an aqueous composition having a total solids content of below 300 g/l and which contains a textile crosslinking agent and 10 to 150 g/l polyethylene glycol, drying the fabric or yarn and curing the product, and optionally washing the fabric or yarn, and thereby producing a product wherein substantially all the polyethylene glycol is substantially permanently bonded on to the fibres.

The product is made by applying and curing the polyethylene glycol onto the fibres as a dilute solution and optionally washing the fabric. Thus the curing may sometimes be performed in such a way that some (e.g., 0 to 10% or 20%) of the polyethylene glycol remains unreacted. Preferably there is substantially no unreacted polyethylene glycol, but the product is generally given a thorough wash after curing to remove unreacted polyethylene glycol to produce a washed product wherein the polyethylene glycol is permanently bonded to the product and is present in an amount 0.5 to 8%. By saying that substantially all the polyethylene glycol is permanently bonded we mean that the amount which can be removed by subsequent washing (after the first wash) is acceptably low. In practice this generally means that at least 80%, and most preferably at least 90%, of the washed add-on of polyethylene glycol will remain on the fabric, or a fabric formed from the yarn, after a further 20 washings at 40°C. As a result, the fabric does not significantly change its properties when it

is subjected to the normal washing encountered by a clothing fabric.

A textile cross linking system is normally utilised to cross link the polyethylene glycol on to appropriate reactive groups of the relevant fibres of the fabric or yarn. These fibres are preferably cellulosic, wool or polyamide fibres. Preferred fibres are cellulosic, and in particular they are preferably cotton or viscose (including modified viscose such as Molinease), with cotton fibres being particularly preferred. The yarn or fabric can be formed solely from the specified fibres or from other fibres as well, for instance the yarn or fabric can be formed from a blend of cotton and polyester. The amount of cellulosic or other reactive fibres is usually at least 30%, and preferably at least 60%, by weight of the fibres in the fabric.

Preferred products of the invention comprises cellulose fibres and the 0.5 to 8% add-on of polyethylene glycol is based on the weight of cellulosic fibres in the product. The preferred cellulosic fibre is cotton.

The textile crosslinking agent will be selected having regard to the chemical reactivity of the fibres on to which the polyethylene glycol is to be reacted. The preferred curing agent is a bifunctional or polyfunctional reagent that will react with hydroxy groups in the polyethylene glycol and hydroxy or other reactive groups in the cellulose or other fibres. Typical cross linking agents for this purpose are alcohols, triazones, aldehydes such as glyoxal and methylol urea derivatives that will react with the fibres and polyethylene glycol in preference to undergoing self-polymerisation.

The preferred crosslinking agent is preferably a textile crosslinking agent having two or more N-methylol groups. In particular, it is preferred that the crosslinking agent is a dimethylol cyclic alkylene urea derivative. The preferred cross linking agent is dimethylol dihydroxy cyclic methylene or ethylene urea.

The total add-on of polyethylene glycol and crosslinking agent on the product is generally in the range 1 to 12%, based on the dry weight of the product. The combined dry weight of the polyethylene glycol and the crosslinking agent preferably provides at least 70%, and usually at least 85% of the total add-on to the fabric or yarn and thus the total add-on is also generally within approximately the range 1 to 12%, or perhaps up to 15%.

The advantage of the invention is that the provision of these relatively low add-ons of permanently cured material comprising polyethylene glycol allows for very useful modification of the properties of the cotton or other cellulosic or other fibres but at on add-on value which is sufficiently low that the handle of the product is not deleteriously affected. In particular the fabric, or fabric formed from the treated yarn, has a weight which is substantially the same as the untreated fabric and which has a very satisfactory handle and yet can have significantly improved properties.

The fabric proposed by Bruno and Vigo had a PEG:crosslinking ratio of approaching 5:1 and was made using a 50% PEG solution. We find that this also contributes to unnecessary weight and adverse handle properties. In the invention the ratio is generally not more than 3:1 preferably it is not more than 2:1. It can be low as 0.1:1 but is usually in the range 0.5:1 to 1.5:1, preferably 0.7:1 to 1.3:1.

The polyethylene glycol (and crosslinking agent) must be distributed substantially uniformly through the product in order that the product has suitably uniform properties. The product can be yarn, in which event fabric can subsequently knitted or woven from the yarn, but preferably the product is a fabric.

The impregnation with the aqueous composition can be by contacting the yarn or, more usually, the fabric with a limited amount of the aqueous composition. Preferably the process is conducted by saturating the fabric or yarn with

the aqueous composition and then expressing excess aqueous composition out of the product to give the desired add-on. Generally the total dry add-on is below 15%, preferably below 12% and the total polyethylene glycol add-on is generally below 8%.

The aqueous composition normally contains at least 30g/l and often 40 or 50g/l polyethylene glycol. However it is undesirable for the amount of PEG to be too high and so it must be below 150g/l, preferably below 120g/l and most preferably below 100g/l.

The total solids content of the aqueous composition is generally at least 50g/l and usually at least 100g/l. It is not normally above about 250g/l and best results are generally achieved with concentrations of 100 to 200g/l, for instance up to about 160g/l.

The wet add-on (after squeezing but before drying) will be such as to give the desired dry add-on having regard to the concentration of the treatment solution. Since the total dry add-on is normally below 15% preferably below 12% and the total solids content of the treatment solution is generally below 300g/l and most preferably below 200g/l, the wet add-on will usually be below 90% (weight of aqueous composition after squeezing based on the dry weight of the impregnated fabric) and preferably it will be below 70%. Wet add-on values of 10 ro 20% to 50 or 60% are often preferred.

The dry add-on of PEG is usually at least 1%. Good results are obtained in many fabrics with dry add-ons of 1 to 5% PEG, for instance 2 to 4% PEG. However in some products (especially when cooling properties are the primary interest) optimum results are obtained with amounts of PEG above 3%, for instance above 4 or 5%, but usually not more than 7%.

The total dry add-on of the composition (consisting essentially of PEG and cross linking agent and optional minor components) is usually in the range 1 to 12%, and is

generally above 3% and often above 5%. For instance suitable values are 7 to 10%.

Products which are intended to give a cooling effect are usually formed wholly or mainly of cellulosic fibres. They can be of linen or modified viscous but preferably the fibres comprise or consist of cotton. The fabric must be sufficiently permeable that movement of the fabric on the wearer inevitably creates a pumping and/or a venturi effect between the yarns of the fabric thereby causing air to pass through the fabric.

The polyethylene glycol on the fabric causes the fabric to absorb moisture rapidly from its surrounding environment. The greatest humidity will, in hot weather, originate from the wearer's side of the fabric due to humidity and moisture being liberated from the skin of the wearer. If the fabric is in contact with the skin, this direct contact will lead to absorption. Usually the fabric is not in tight contact with the skin in which event the skin moisture will increase the humidity of the air between the skin and the fabric and the fabric will absorb this humidity.

Movement of air through the fabric will cause evaporation of moisture from the fabric and the latent heat of evaporation will cool the fabric. This mechanism will operate best when the external atmosphere is dry and of relatively low humidity, but even in humid tropical climates the humidity of the external air is usually sufficiently below the humidity adjacent the skin that the cooling mechanism will still occur.

It is necessary for the cooling mechanism to occur satisfactorily, that the fabric should absorb and desorb moisture very rapidly. In this specification we are using the word absorb as a generic word to include both adsorption on to the surface of the fibres and absorption into the core of fibres.

Optimum results are obtained with the low polyethylene glycol add-on values of the invention since these give fast

pick-up of adequate moisture to give a strong cooling effect, but without providing a permanently wet and potentially heavy reservoir which may reduce the cooling effect and is, in any event, unnecessary and undesirable. For instance it is generally desirable, especially in hot weather, for the fabric to be as light as possible and so it is undesirable to load on to it unnecessary polyethylene glycol. Further, the overall properties of the fabric, both as regards cooling performance and other properties, do not seem to be improved by increasing the amount of polyethylene glycol above about 8%. In addition it has been found that PEG within this range can be grafted onto the cellulose through an ester leakage from a methylol group to give the desired effect with minimum disadvantageous effects.

In order that the fabric allows sufficient movement of air through the fabric, it must have adequate permeability to allow this movement. The preferred fabrics are substantially square woven fabrics since this promotes the pumping or venturi effect. For example, a suitable fabric has 60th/inch in the warp and 60th/inch in the weft and is composed of 2/100's cotton yarn or 1/50's cotton yarn. Alternatively a fabric composed of 80th warp and 64th in the weft will have a more rectangular slot. What is not ideal is to have a warp faced cloth such as a poplin where the warp threads would be approximately 120th/inch and the weft 60th/inch. Thus preferably the number of warp threads is from 50 to 90 (usually 60 to 84) per inch and the number of weft threads is 0.7 to 1.3 times (usually 0.8 to 1.2 times) the number of warp. Generally the warp and weft threads are of the same or similar yarn type.

Preferred permeable fabric according to the invention has uniform impregnation with polyethylene glycol and is formed from yarn comprising cotton fibres and has a rate of absorption of water which approximates to or is faster than the rate of absorption of a corresponding fabric wherein the cotton fibres are replaced by linen fibres and the

polyethylene glycol impregnation is omitted. Thus, in the invention, it is possible to modify cotton fibres by the impregnation with polyethylene glycol so that the modified fabric containing cotton has a rate of absorption approaching or exceeding the rate of absorption of the corresponding fabric which has not been treated with polyethylene glycol and wherein the cotton fibres have been replaced on a weight for weight basis with linen fibres, all other components of the fabric being unchanged. Thus the comparative fabric should be made using the same weave and to the same weight and with the same blended fibres, if any are present in the cotton fabric.

The rate of absorption can be measured by applying the fabric against a suitable substrate, applying water to one point on the fabric and measuring the rate of wicking of water across the fabric. A particular test is put a fabric composed of 100% polyester on top of a cotton fabric treated according to the invention. Within a period of 60 seconds the drop of water can be seen to change its contact angle from around 60 degrees to less than 30 degrees and the water droplet is pulled through to the base fabric where it spreads very rapidly. When the corresponding untreated cotton fabric or the untreated corresponding linen fabric are tested in the same way, the times for the linen fabric are similar but the times for the untreated cotton are much slower. Fabrics according to the invention preferably have a rate which is at least 80%, most preferably at least 90% and usually at least 100%, for instance up to 120 or 150%, of the rate of wicking of the corresponding linen fabric without the PEG impregnant.

In the invention, a permeable fabric is used to give a cooling sensation to a wearer, and the fabric has uniform impregnation with permanently bonded polyethylene glycol and the fabric absorbs moisture from between the skin of the wearer and the fabric and movement of the fabric by the wearer causes air to pass through the fabric and thereby evaporate the absorbed moisture and cool the wearer. The

amount of polyethylene glycol should normally be at least 3% in order to obtain a strong cooling effect under appropriate conditions, but lower amounts, e.g., down to 0.5%, are suitable in many products, especially non-iron cotton.

Although it is preferred that the fabric which gives the increase rate of absorption and/or the fabric which gives the cooling sensation, as discussed above, should be a fabric according to the invention containing 0.5 to 8% polyethylene glycol substantially all of which is substantially permanently bonded to the fibres of the fabric, the invention also includes such fabrics wherein different amounts of polyethylene glycol or other polyhydroxy compound are substantially permanently bonded on to the fabric whereby the specified cooling and absorption properties are obtainable without unacceptably damaging the other properties of the fabric.

When carrying out the manufacturing process of the invention with saturation (i.e, application of excess liquor) and squeezing of the fabric or yarn, the amount of aqueous bath impregnated on to the fabric or yarn is generally such as to give a final wet pick-up (after squeezing) of around 30 to 110%, often 70 to 90%, by weight, but final wet pick-ups in the range 20 to 70% are often optimum.

The squeezing can be by any conventional way of expressing excess liquid from the fabric, for instance by centrifuging or calendering.

In order to cause curing of the crosslinking agent and polyethylene glycol onto the fibres, the aqueous composition of polyethylene glycol and crosslinking agent will generally include catalysts, and it may include other additives.

Conventional catalysts are inorganic or organic acids such as citric acid or succinic acid, and/or acidic salts such as magnesium chloride. It is particularly preferred to use a non-phase separating curing agent such as

triethylene glycol citrate or other water soluble polyester of citric acid. The amount of the catalyst or catalyst mixture is usually from 2 to 40%, often around 5 to 25%, by weight of the urea or other cross linking agent. Expressed in terms of the concentration of catalyst in the impregnation solution, the amount is usually in the range 2 to 20g/l.

The drying is conducted under conventional conditions, such as heating at below 100°C for sufficient time to remove most or all of the water on the fabric. The fabric may be cured immediately or subsequently. For instance the dried fabric may be stored and/or transported (optionally under refrigeration) prior to being made up into clothing and then cured into the made-up configuration. Thus the dried fabric may be made into a shirt and then cured.

Curing is effected by heating at an appropriate curing temperature or otherwise activating the cross linking system by irradiation in known manner. Preferably the curing is by heating, for instance by hot air while the fabric is stretched on a stenter.

The optimum cure temperature is related to the duration of cure in that higher temperatures require shorter cure durations and lower temperatures require longer cure durations. For instance in many processes the cure temperature is at least 130°C, preferably 145 to 180°C and most preferably around 155 to 170°C, since lower temperatures appear to give inadequate permanent cure of the polyethylene glycol on to the fabric. The curing is preferably by flash curing, e.g for a period of 0.1 to 2, usually 0.2 to 1.2 minutes, often about 0.5 to 1 minute. However cure temperatures of 100 to 130°C, for instance 110 or 120 to 130°C can be used especially if the curing period is longer, typically up to 3 or 4 minutes.

The described temperatures are particularly suitable when the cross linking agent is dimethylol dihydroxy ethylene urea and adjustments in the temperature and time may be required to compensate for more reactive or less

reactive cross linking agents. The use of the lower cure temperatures, for instance 110 to 140°C and preferably 110 to 130°C are particularly preferred where it is desired to provide a white fabric as it reduces the risk of yellowing.

The preferred total add-on's of 5 to 12%, often 7 to 10%, and polyethylene glycol add-on's of 0.5 to 8% by weight are capable of not only giving good cooling properties but may also give other useful benefits such as soil release, increase resistance and/or abrasion resistance. These other properties can be achieved at lower add-on's of PEG, for instance 0.5 to 3%, often 1 to 3%, and at lower add-on's of polyethylene glycol and crosslinking agent, for instance 1 to 5% and often 2 to 5%. Accordingly when properties other than the cooling properties are required, it may be preferred to operate at these lower add-on's. The impregnating solution generally then has a polyethylene glycol concentration of 10 to 50, often 10 to 30 g/l and a total solids content of below 200 g/l, often below 120 g/l. Usually it is above 20 g/l.

The described impregnation and cure gives improved crease resistance as measured by crease recovery angle. It also gives improved wet recovery and thus the fabric is easy to iron or even non-iron. It gives improved resistance to abrasion.

The fabrics also have improved soil release properties. This is particularly surprising since soil release properties are normally achieved by rendering a fabric hydrophobic, but the process of the invention renders the fabric more hydrophillic.

Another surprising benefit of the invention is that the treatment increases the affinity of the fabrics to optical whitening agents and the so-called direct dyes and/or reactive dyes. Accordingly it is possible easily to obtain fabrics which not only have the described cool and easy care properties but also improve whitening effect and/or improved dyeing. The optical whitening agent is preferably a fluorescent material and the invention appears

to give its desired effect as a result of reducing the tendency for fluorescent quenching to occur. Thus the invention allows maximum fluorescence to be achieved.

Another surprising benefit of the invention is that fabrics having particularly soft hand can be achieved by including a hydroxy-substituted silicone in the aqueous bath. The hydroxy silicone is usually present in an amount of 0.2 to 3%. It is cured into the fabric with the polyethylene glycol and the cross linking system and imparts permanent hydrophilic properties and permanent flexibility to the fabric. It gives enhanced crease resistance and abrasion properties. It is of particular value when the fabric is based on linen since some linen fabrics can have a rather stiff hand.

Another way of improving the hand of cotton or other fabrics is to include a small amount of plasticiser with the PEG. For instance partially hydrolysed polyvinyl alcohol (typically 97% hydrolysed) can be used in an amount of 5 to 30g/l. The total add-on of PVA is preferably less than 2% and generally less than 1%. When polyvinyl alcohol or other plasticiser is included, preferably the combined amount of PEG and plasticiser is below 8% but in some instances it may go up to 9% or 10% maximum. In particular, if the amount of polyvinyl alcohol or other plasticiser is above 10g/l, the amount of PEG may be reduced in proportion to it.

Various additives may be included in the impregnation solution in order to impart additional desirable properties to the treated fabric. For instance it is desirable to incorporate a polymeric biguanide hydrochloride such as the material commercially available from Zeneca under the trade name Reputex. This contributes to providing permanent freshness and elimination or reduction of body odours. Any bacteriastat which is suitable for fabrics and which does not cause yellowing can be used.

The permanent bonding of the generally small amount of polyethylene glycol to the fabric can also give advantages

in other areas. In particular, the resultant fabric has high hydroxyl reactivity to materials that will react with hydroxyl groups, especially isocyanates. Accordingly an isocyanate-based polymer can be securely bonded to the fabric as a result of the formation of urethane linkages due to reaction between the hydroxyl groups of the fabric and the isocyanate groups of the resultant polyurethane.

It is known to make interlining fabrics by applying a heat and pressure-sensitive urethane adhesive to the interlining fabric, whereupon this interlining fabric can be heat cured on to an outer fabric by ironing. In the invention, it is particularly desirable to use, as the initial fabric substrate, a permeable fabric of the invention. Further, the same results can be achieved even when the interlining fabric is a non-woven fabric.

Thus, the invention includes also non-woven or other fabric comprising fibres of cellulose, wool or polyamide (preferably cotton) which has uniform impregnation with polyethylene glycol permanently bonded to the fabric and which carries a urethane adhesive coating cured on to the fabric.

The invention also includes laminates of the fabric carrying a heat and pressure-sensitive adhesive coating covered by a release substrate, and heat bonded laminates formed by hot pressing the fabric carrying the adhesive coating on to an outer fabric. When the fabric having the impregnation with polyethylene glycol has high permeability, as is preferred, the resultant laminate has good permeability, good moisture transmission, and a good permanent bond between the interlining substrate and the outer fabric.

Fabrics according to the invention which are to give a cooling sensation when warm can be sportswear, casual wear or loose external wear such as mens head wear Ghuttra and Schmagh; ladies head-dress such as Sheliagh and Hejab; mens outer wear such as Thobe or Dish Dasha and ladies outer wear such as Abba.

The following are examples of the invention.

Example 1

A cotton voile used for the manufacture of Ghuttra made from 2/100's cc yarn and having 60th/inch in both warp and weft direction. The yarn had been gas singed and mercerised before weaving.

The fabric was again singed and mercerised and then boiled in a 10g/l solution of Caustic Soda in a kier for 8 hours. The fabric was then washed and partly bleached in a solution of Sodium Hypochlorite of at least 1.5g/l available chlorine. It was then given a repeat treatment. After which it was given a peroxide bleach at 40°C. A high white with a reflectance of 89% was obtained.

The fabric after drying was padded through the following aqueous solution:

80g/l Polyethylene glycol approx 1,000 mw

120g/l 45% aqueous solution of dimethylol dihydroxy ethylene urea

12g/l Magnesium chloride

1g/l Citric acid

5g/l Polyvinyl alcohol

5cc Uvitex RSB (Ciba Geigy) optical whitening agent

50cc of a 65/35 mixture of 2g/l Vat Blue and Vat Red for tinting purposes

After padding the material was passed through a mangle to give a wet pick-up of about 80% by weight. It was then dried while stretched on a stenter and exposed to hot air and flash cured while exposed to very hot air for about 30 to 60 seconds, the temperature during the curing being about 160°C. The fabric was then washed in hot water at about 40°C and dried. The free formaldehyde was less than 25 ppm.

The resultant fabric had a dry add-on of 9.2%. The fabric was very hydrophilic and extremely cool to touch. It was crease resistant, easy care, and had a high degree of optical whiteness, mercerised at 65%RH.

The fabric had very fast moisture adsorption. It was resistant to shrinkage and there was no measurable diminution of properties even after 4 consecutive washes at 60°C for 15 minutes. Strong anti static properties were noted and an improvement of 20° (warp and weft) in crease recovery was obtained.

The rate of moisture absorption, measured by the time in seconds to spread 1cc from a mean pipette to approximately 0.5cm wide was 1.8 seconds. This compared to a value of 1.6 seconds when the voile was formed from linen instead of cotton with the same yarn weight and weaving pattern.

Example 2

A fabric composed of 50:50 blend of cotton and Modal was constructed from 40's count yarn to give 52th/inch warp and 48th/inch weft. The fabric was padded through:

80 g/l Di hydroxy cyclic ethylene urea
80 g/l PEG 1000
4 g/l Magnesium chloride
1 g/l Citric acid

Mangle expression 80%

The fabric was stenter dried and cured for 1 minute at 150°C. It was then washed at 40m/min through a bath of hot water at 60°C and stenter dried to width. The fabric was very absorbent and had a high Performance Index i.e. % increase in CR/% decrease in abrasion (Accelerator). This was found to be 1.5%

Example 3

A fabric composed of 50% linen and 50% Modal was made from 20's yarn with a set 46th/inch warp and 44th/inch weft prepared and bleached and was treated with

80 g/l Di hydroxy cyclic ethylene urea
50 g/l PEG 1000
10 g/l Hydroxy silicone
6 g/l Magnesium chloride
1 g/l Citric acid

Mangle expression 80%

The fabric was dried and cured in the standard way. It was not washed off. The performance index was 2.4. This was a very good result for a fabric with 50% linen.

Example 4

A fabric composed of 200% linen and constructed from 25's lea bleached linen yarn with 38th/inch warp and 36th/inch in the weft. The fabric was prepared in a normal way and mercerised. It was then treated with a solution of:

60 g/l Di hydroxy cyclic ethylene urea
50 g/l PEG 1000
10 g/l Hydroxy silicone
2 g/l Polyester activator

80% mangle expression

The fabric was dried and cured in the normal way. It was found to have a 38% increase in CR and a 30% decrease in abrasion giving a Performance Index of 1.26. The fabric had a cool touch and was very absorbent.

Example 5

A fabric composed of 100% cotton and made from 60's cc yarn and with a set of 80th/inch warp and 67th/inch weft. After standard preparation was treated with:

80 g/l Di hydroxy cyclic ethylene urea
50 g/l PEG 1000
4 g/l Magnesium chloride
1 g/l Citric acid

Mangle expression 80%.

The fabric was dried and cured in the standard way at 150°C. The fabric was very absorbent and had a cool touch. The Performance Index was 1.21.

Example 6

A fabric as above was treated with:

80 g/l Di hydroxy cyclic ethylene urea
30 g/l PEG 1000
10 g/l Hydroxy silicone
6 g/l Magnesium chloride

1 g/l Citric acid

The fabric was dried and cured as above. The fabric was absorbent and had a cool handle. The Performance Index was 0.97.

Example 7

A pure cotton fabric prepared and bleached in the normal way and having the following specification:

Threads/square inch Warp 60
Weft 60

Yarn count Warp and Weft 24s cc

was impregnated with the following solution

80 g/l Di methylol di hydroxy cyclic ethylene urea (Arcofix, trade mark),

20 g/l PEG 1000

4 g/l Magnesium chloride

2 g/l Citric acid

80% mangle expression

Dried and flash cured at 160°C, the result was excellent soil release properties.

Example 8

A pure cotton fabric prepared and bleached in the normal way and having the following specification

Threads/square inch Warp 60
Weft 60

Yarn count Warp and Weft 24s cc

was impregnated with the following solution

100 g/l Di methylol di hydroxy cyclic ethylene urea (Arcofix, trade mark),

15 g/l hydroxy silicone (Edunine, trade mark)

20 g/l PEG 1000

4 g/l Magnesium chloride

10 g/l Citric acid

The fabric was dried and flash cured in the normal way; the result was a high Performance Index:

percentage increase in crease resistance 80

percentage decrease in abrasion (accelerator) 30

Example 9 (Comparative)

A fabric composed of 100% cotton and constructed from 20's cc yarn and a sett of 40th/inch in warp and weft was treated with:

110 g/l Di hydroxy cyclic ethylene urea
500 g/l PEG 1000
4 g/l Magnesium chloride
1 g/l Citric acid

The fabric was prepared in the normal way.

Mangle expression 80%

The fabric was stenter dried and cured at 150°C. The fabric had a harsh handle and a clammy heavy handle. It was very absorbent and had a Performance Index of 1.1. The handle remained harsh and stiff even after washing at 40°C.

When this process was repeated with curing at 100°C, it was found that after two consecutive washes at 60°C, no significant add-on of polyethylene glycol remained on the fabric.

Example 10

A 100% cotton shirt fabric was immersed in a solution of:

80g/l bifunctional reactant (Arkofix, the trade name for a Hoechst dihydroxy dimethylol cyclic ethylene urea)

80g/l ethylene glycol at mol weight 1000

20g/l Eudnine (a water soluble hydroxy silicone, trade mark of Zeneca)

8g/l magnesium chloride

It was then centrifuged to give a total wet add-on value of 31% on the weight of the garment. The shirts were then dried and cured for approximately 3 minutes at a temperature of 120°C. The temperature can be 180°C in which case the curing time should be reduced by speeding up the machine, i.e., 30m/min increased to approximately 50m/min. Instead of 8g/l magnesium chloride an alternative is 1g/l citric acid plus 4g/l magnesium chloride.

Alternatively, the fabric could be dried and then transported to a shirt manufacturer under refrigeration, made up into a shirt and then subjected to curing at a temperature of, for instance, 120°C for three minutes.

Example 11

A composition which gives a particularly soft handle is:

80g/l dihydroxy dimethylol cyclic ethylene urea (45% solids)

15g/l partially hydrolysed PVA

65g/l PEG 1000, 1g/l citric acid

4g/l magnesium chloride.

CLAIMS

1. A process for treating a fabric comprising cellulose, wool and/or polyamide fibres, or the yarn from which the fabric is formed, comprising impregnating the yarn or fabric with an aqueous solution having a total solids content of below 300 g/l and which contains a textile crosslinking agent and 10 to 150 g/l polyethylene glycol, drying the fabric or yarn and curing the fabric or yarn and optionally washing the product and thereby producing a product in which there is 0.5 to 8% polyethylene glycol substantially all of which is substantially permanently bonded onto the fibres.

2. A process according to claim 1 in which the amount of polyethylene glycol in the aqueous solution is 40 to 100g/l and the total add-on is 1 to 15%.

3. A process according to claim 1 in which cotton fabric is impregnated with the solution, the fabric is dried and made up into a garment, and the garment is then cured.

4. A fibrous product which is selected from fabrics and yarns and which comprises fibres of cellulose, wool and/or polyamide and which includes polyethylene glycol substantially uniformly distributed throughout the product and in which the polyethylene glycol is present in an amount of 0.5 to 8% (based on the dry weight cellulose, wool and polyamide) and substantially all the polyethylene glycol is substantially permanently bonded to the fibres.

5. A product according to claim 4 in which the polyethylene glycol is substantially permanently bonded to the fibres by a textile crosslinking agent, the total add-on is 1 to 15%, the total amount of polyethylene glycol and crosslinking agent is 1 to 12% by weight, and the weight ratio of polyethylene glycol:crosslinking agent is between 0.1:1 and 2:1.

6. A product according to claim 5 in which the textile crosslinking agent has two or more N-methylol groups.

7. A product according to claim 5 in which the textile crosslinking agent is dimethylol or dihydroxy cyclic ethylene or methylene urea.

8. A product according to any of claims 5 to 7 in which the product is a permeable fabric, comprising cellulose fibres, the amount of polyethylene glycol is 3 to 8% and the amount of polyethylene glycol and textile crosslinking agent is 5 to 12% (by weight of cellulose fibres).

9. A product according to claim 5 which is a permeable substantially square woven fabric.

10. A product according to claim 5 or claim 6 in which the fibres are wholly or mainly cellulose and comprise at least 30% by weight cotton.

11. A permeable, substantially square woven, fabric permanently impregnated with polyethylene glycol and formed from yarn which comprises cotton fibres which has a rate of absorption of water which is at least 80% of the rate of absorption of the corresponding unimpregnated fabric wherein the cotton fibres have been replaced by linen fibres.

12. A product according to any of claims 4 to 7 in which the amount of polyethylene glycol is 0.5 to 3%.

13. A product according to any preceding claim in which the polyethylene glycol has molecular weight 400 to 2000.

14. A product according to any of claims 4 to 13 in which hydroxy substituted silicone is substantially uniformly distributed throughout the product and cured on to the fibres with the polyethylene glycol and is present in an amount of 0.2 to 3%.

15. A product according to any of claims 4 to 14 which is a fabric and which carries a urethane adhesive coating cured onto the fabric by reaction between isocyanate groups of the adhesive and the polyethylene glycol.

16. A product according to claim 15 wherein the adhesive is heat curable and is covered by a release layer.

17. A product according to claim 15 wherein the fabric is permanently bonded to another fabric by the adhesive.